Appendix One

Summary of berry productivity data from Rock Creek permanent plots

There are two 0.5 x 1.5 m "berry plots" in each vegetation replicate plot in the forest and treeline sites, and two in one of the replicate plots at the tundra site (#2). The number of berries of all species occurring in each of these plots is counted in early August each year. The design of this monitoring element appears to be aimed at quantifying the berry productivity **per unit area** of the sampled communities because the abundance of berry-producing species (in terms of cover, density, biomass) was allowed to vary among the plots. Thus the units for the berry productivity measurements should be expressed in berries produced per m^2 of ground area.

Treeline berry plots 1994-1997

Data for the two most abundant berry-producing species in the treeline vegetation plots over the period 1994 to 1997 give an indication of the problems in analyzing this data (figs. a1 and a2). Notice that the degree of variation in berry production is greater **within** plots (same colored lines) than between plots and also that the direction and magnitude of the yearly differences sometimes varies both within the replicate plots and between them. It is difficult to know what calculating a plot mean for the two berry plots within each replicate really tells us, with this pattern of variability. In some cases, such as for both *E. nigrum* and *V. uliginosum* berry production in treeline plot #2, taking a plot mean makes sense because the responses are parallel, indicating that they would be in the same "stratum", if the design were stratified.

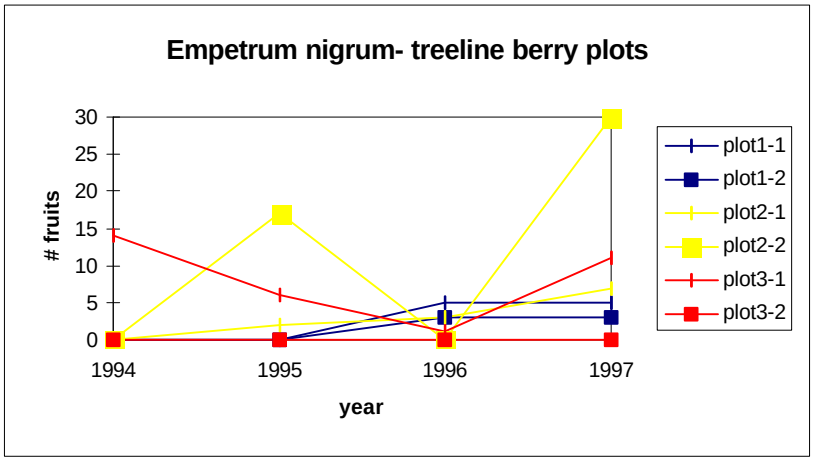

Fig. A1. Number of crowberries (*E. nigrum*) produced in six berry plots within three treeline vegetation replicate plots from 1994 - 1997.

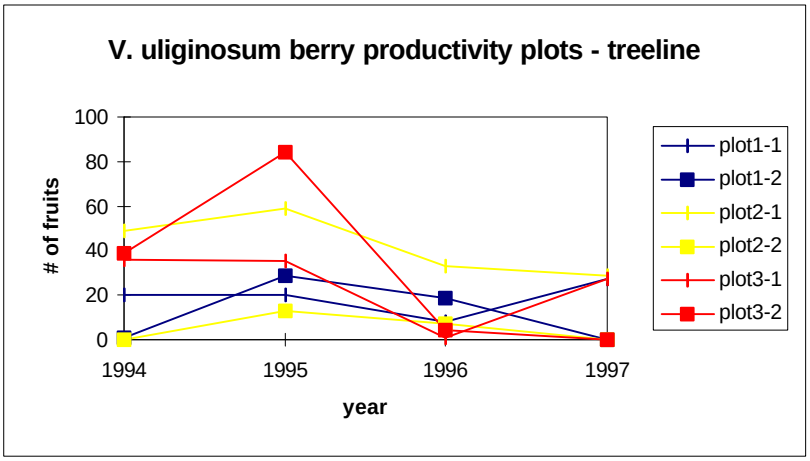

Fig. A2. Number of blueberries (*V. uliginosum*) produced in six berry plots within three treeline vegetation replicate plots from 1994 - 1997.

Forest berry plots 1994-1997

There is less *haphazard* variability in the berry production data from the forest site, on the whole, as compared to the treeline site (see Figs. A3-A5). Abundance of low-bush cranberry (*Vaccinium vitis-idaea*) fruits, for example, although it is very variable between plots, (and essentially absent from plot #1) shows consistent patterns within the replicate plots. Variability in berry production of the other two dominant berry-producing species is often higher within replicate plots (those with same-colored lines) than among them (as was the case for treeline plots) and in some cases, there are very divergent year-to-year patterns both within and among replicate plots. For instance, there was a steep increase in crowberry (*E. nigrum*) productivity for berry plot3-1 in 1996 over 1995, that was observed in the other plot berry plot (plot3-2). Similarly, there was a substantial increase in crowberry production in plot 1 in 1997 over 1996 not shown by berry plots in replicates two and three, (in fact there was a steep decrease in crowberry production plot3-1 for this year).

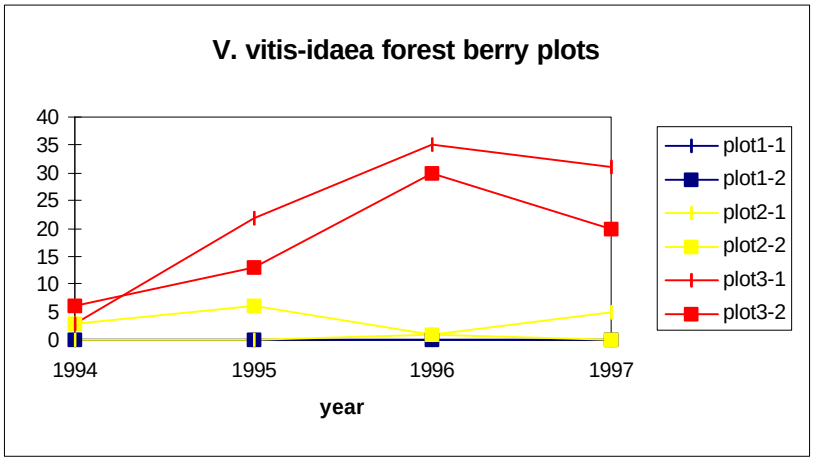

Fig. A3. Number of low-bush cranberries (*V. vitis-idaea*) produced in six berry plots within three forest vegetation replicate plots from 1994 - 1997.

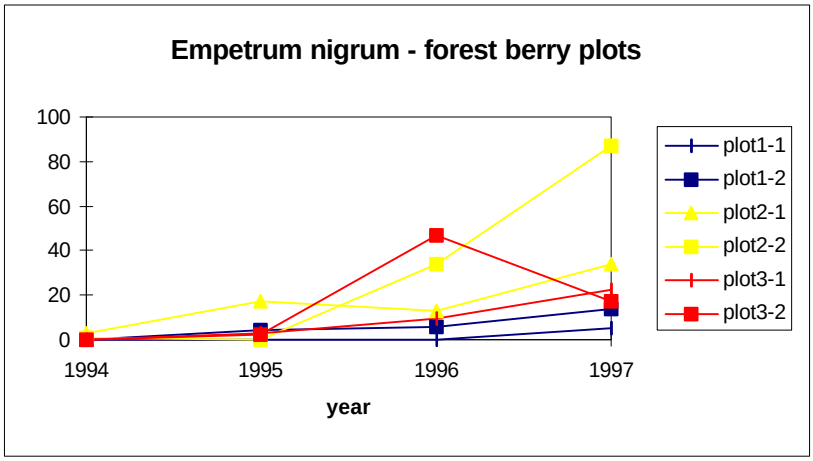

Fig. A4. Number of crowberries (*E. nigrum*) produced in six berry plots within three forest vegetation replicate plots from 1994 - 1997.

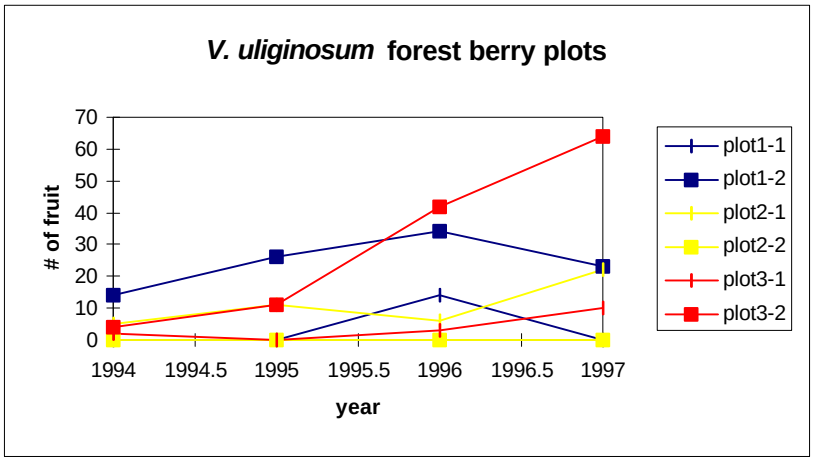

Fig. A5. Number of blueberries (*V. uliginosum*) produced in six berry plots within three forest vegetation replicate plots from 1994 - 1997.

The degree and types of variability in berry count data within this four-year dataset suggests several issues that may need to be addressed to move forward with a more effective monitoring strategy for this parameter. One concern is that there may be plot-size issues that factor into the large (and haphazard) variability within and among plots at the monitoring sites. It would perhaps be better to mark individual plants (stems) and make berry counts based on a per plant (or stem) sampling scheme for some taxa.

Comments on the design of the berry productivity study

The location of the berry plots were not chosen at random, but (according to the protocol) were placed “in microsites or clones where one or more of three of the most common berry species (were) productive”. How this determination was made, and over what time frame it was made, is not stated in the protocol. Clearly, choosing a “productive” microsite for one species could result in built-in biases not only for productivity data on the species in question, but also for the data collected on the other species in the plot. The plot location biases, if a

formal part of the study design, should have been the same for all plots chosen (i.e. consistency in the nature of the bias).

Another complicating factor in the design of the berry production monitoring protocol is that formal consideration was not given to environmental variability within the study plots that might reasonably be expected to have important influences on berry productivity (i.e. degree of shade, microhabitat characteristics, density of competing shrubs, herb layer etc...). A sampling scheme that stratified “types” of berry habitat within the plots (areas with substantially similar habitat characteristics), and sampled that variability would be one way of addressing this concern.

The experimental design of the berry production component of the Rock Creek LTEM project is, in my view, problematic. The design flaws (unknown degree and type of bias) make comparisons between sites, (for instance forest and treeline) as well as extrapolation of the results to larger spatial scales subject to serious question.

The fact that the cover, basal area, stem density or other abundance measures of the berry species in each berry plot were not quantified is another potential problem because of the large differences in the abundance of the target species among the plots. In fact, although comparisons are made for all berry-producing species, some taxa are entirely absent from some plots (and are abundant in others). Hence, the variation in numbers of berries is largely due to differing biomass of berry producing taxa among plots. It could be argued that since the sampling unit is area-based, these differences in abundance are not necessarily a problem, because it is the productivity of the community (per unit area), that is being quantified. Unfortunately, since the berry plots were not chosen at random, it is hard to see that such an argument would be justified.